



Semester 2 Examinations 2018 / 2019

Exam Code(s) 4BCT, 4BP
Exam(s) Fourth Year Computer Science and Information Technology
Fourth Year Electronic and Computer Engineering

Module Code(s) CT414
Module(s) Distributed Systems

Paper No. 1

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Instructions: Answer any 4 out of the 5 questions.
All questions carry equal marks.

Duration 2 hours
No. of Pages 5
Discipline Information Technology
Course Co-ordinator Dr D Chambers

Requirements None

- 1: Using Java Remote Method Invocation, outline the design for an Internet based automated assessment system for the university. The server allows users to authenticate themselves and download an assessment object. The system uses an interface that provides methods to retrieve and answer a list of multiple-choice questions. The (updated) assessment object can then be submitted back to the server for verification and correction. The design of the system should make it possible for new Assessment implementation classes to be easily added to the server in the future, making the system very flexible.

The design should use Java RMI and Object Serialisation to download and then submit objects that implement the Assessment interface i.e. these objects are passed by value from the server to the client and then back again to the server. Full implementation classes (for *ExamServer* and *Assessment*) are not required but the answer should include full source code for the Java interfaces and mainline client and server code as described below:

- *ExamServer* - this remote interface should provide methods for user authentication, download of assessments and the submission of completed assessments. Assessments can only be downloaded and submitted during certain specified time intervals. Include definitions for any exceptions that may be required in method definitions. 7 MARKS
- *Assessment* - this serializable interface should provide methods for the retrieval of information about the assessment, and the retrieval / answering of questions. It should also have a method to output the selected answer to each question - the answer provided to a question can then be changed, if desired, prior to submission of the assessment. 8 MARKS
- Provide the mainline server code required to fully initialise the server and then register an instance of the *ExamServer* implementation class in the RMI Registry. 5 MARKS
- Provide a simple client program that can use or interact with the server i.e. it downloads an assessment object, completes the assessment and then submits the assessment object back to the server. 5 MARKS

- 2:a: What is *message oriented middleware* and what types of messaging models are available in the Java Messaging Service? 5 MARKS
- b: You have been asked to design an application that allows weather updates on specific areas to be retrieved from a central web server and then forwarded periodically to interested client applications. Describe a suitable architecture and design for a distributed application that uses the Java Messaging Service (JMS) to handle the distribution of the weather update messages. Full Java source code is not required but your answer should provide a full description of how the JMS could be used within the application. Also describe how the application might use the Java Naming and Directory Interface (JNDI) as part of this solution. 10 MARKS
- c: Assume that you have been contracted by a large multinational company to develop an enterprise class client / server application that may be accessed by a large number of clients concurrently. You will therefore need to employ some form of load balancing in the design of the application. What type of load balancing algorithm would you recommend? Are there any alternatives available? Provide some technical justification and rationale for your recommendations, including an evaluation of the results of any related case studies that you are aware of. 10 MARKS
- 3:a: Explain the role of the Proxmox Virtualisation Environment. In this context, what is the difference between a Virtual Machine and a Container? 6 MARKS
- b: How is it possible to run Virtual Machines at near native speed using Kernel-based Virtual Machine (KVM) infrastructure? 4 MARKS
- c: What is the purpose of the Ceph storage platform and what advantages does it have over traditional RAID based storage? Describe the high level architecture and the main components of the Ceph storage platform. Include in this description details about the following items: Ceph Network, Object Storage Devices and Ceph Pools. 8 MARKS
- d: What are the advantages of grouping physical servers into a cluster? How does a Proxmox cluster implement High Availability and what might cause a Virtual Machine migration to fail? 7 MARKS

- 4:a: Describe briefly the advantages of using the EJB component framework in the context of high volume distributed object applications. What types of beans may be defined using the EJB framework? 5 MARKS
- b: Suppose you work for a social media company that collects a lot of very large data sets e.g. web logs or other application related data that needs to be stored and analysed. Also assume that the company has access to large scale computing resources based in multiple data centres. Explain how using the Apache Hadoop Distributed File System and its related facilities might help in solving the storage and analysis requirements of the company. Discuss the advantages of this approach over using traditional database systems for this type of data. 8 MARKS
- c: Describe in detail the MapReduce programming model. Outline the architecture for a MapReduce application that could be used to index a large number of text files by the individual words present in each file. Full source code for the application is not required but your answer should include the data structures that could be used and also clearly explain the purpose and functionality of the map() and reduce() functions in solving this problem. 12 MARKS

5: Answer the following questions in relation to Internet routing:

- a: Explain how traceroute works and what it shows. 5 MARKS
- b: State and differentiate the three main means of interconnecting an Autonomous System with another Autonomous System. 3 MARKS
- c: Describe each of the following: Internet Exchange Point, Border Gateway Protocol, Asymmetric Route 6 MARKS
- d: Describe what a Route Server is, what function it performs and why it is necessary. 5 MARKS
- e: The result of running 'show bgp ipv4 unicast 140.203.0.0/16' on an internet facing BGP router of an ISP in Ireland is shown below. What is the best path from that ISP to the NUI Galway network (140.203.0.0/16)? Explain fully in your answer how the best path is chosen in this case. 6 MARKS

```
rtr01#show bgp ipv4 unicast 140.203.0.0/16
```

BGP routing table entry for 140.203.0.0/16

Paths: (3 available, best #x)

```
174 3356 1213 1213
```

```
154.50.192.49 from 154.50.192.49 (154.26.32.227)
```

```
Localpref 100, valid, external
```

```
1213
```

```
194.88.240.15 from 194.88.240.8 (194.88.240.8)
```

```
Localpref 400, valid, external
```

```
1213
```

```
83.220.203.172 from 83.220.203.172 (83.220.203.170)
```

```
Localpref 300, valid, internal
```